

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

A SIX YEARS' STUDY OF CROSSBREEDING SWINE

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Observant stockmen have recognized for a long time that crossbred animals possess certain distinct advantages over purebred or high-grade individuals. Crossbred cattle and sheep have been popular in Scotland for 150 years. In the United States, western sheepmen regularly produce many crossbred lambs, and in the cornbelt a large number of crossbred swine are produced. Wentworth says Denmark has made greater use of crossbreeding than any other nation; that about one-third of the Danish bacon is from swine produced by crossing the English Yorkshire and Danish Landrace animals.

As early as 1899 Shaw at this experiment station demonstrated the superiority of crossbred pigs over purebreds. His experiment, however, is subject to a criticism that is applicable to most experiments on crossbreeding. The numbers were not large enough and the experimental conditions were not as fully controlled as they should have been.

The rather generally accepted attitude is that the crossing of two breeds is of distinct advantage in the production of commercial animals, but that to attempt to use crossbreds themselves for breeding purposes is ruinous. This view has developed largely as the result of observing herds whose owners had continued crossing promiscuously until their herds were but jumbled mixtures rather than true crossbreds. Herds of this type are unsightly and usually unprofitable.

Scientists recently advanced a satisfactory explanation for hybrid vigor. We now know why crossbred animals are generally more vigorous than purebreds. The science of genetics has also given us reasons for believing that crossbred mothers should be superior to purebred or high-grade mothers. While this knowledge has been available, it has not generally been known to stockmen, and the view that crossbreds should not be used for breeding still persists.

Pigs are carried about 112 days before birth, and nursed about 56 days after birth. For 168 days, therefore, their mothers are the main factor in their environment. Consequently, if the crossing of two breeds of swine results in sufficient increased vigor to make crossing worthwhile, the crossbred sows should in turn be sufficiently more vigorous to make better mothers than purebred or high-grade sows.

OBJECTS OF THE EXPERIMENT

This experiment was conducted for the express purpose of answering the following questions:

1. How much added vigor may a farmer expect as the result of crossing two breeds of swine?
2. Should the crossbred gilts all be marketed or can they be used to advantage for further breeding?
3. If the crossbred sows are better mothers, how can they best be used for further breeding?

METHOD OF PROCEDURE

The experiment was begun in the fall of 1928. It was carried out at the West Central School of Agriculture, Morris, Minn., and at the Northwest School of Agriculture, Crookston, Minn.

Attempts were made at the outset to standardize experimental conditions, in order that the environment might be as uniform as possible.

Breeding stock.—Spring-farrowed gilts and boars were used for breeding stock. All of the pigs were farrowed in the spring. The matings for the first year were as follows:

West Central School of Agriculture—

Poland China gilts x Poland China boar
Poland China gilts x Duroc Jersey boar
Duroc Jersey gilts x Poland China boar
Duroc Jersey gilts x Duroc Jersey boar

Northwest School of Agriculture—

Chester White gilts x Chester White boar
Chester White gilts x Duroc Jersey boar
Duroc Jersey gilts x Chester White boar
Duroc Jersey gilts x Duroc Jersey boar

The above matings were repeated the second and third years, and, in addition, the following matings were made:

At the West Central School of Agriculture the crossbred Poland China-Duroc Jersey gilts were mated with a Chester White boar from the Northwest School of Agriculture. At the Northwest School of Agriculture crossbred Chester White-Duroc Jersey gilts were mated with a Poland China boar from the West Central School of Agriculture. The pigs resulting from these matings are designated as three-breed-cross pigs. They are the result of crossbred gilts mated to a boar of a third breed.

In the fourth year of the experiment and for the last three years, the Yorkshire breed was substituted for the Chester White and the Poland China for the Duroc Jersey at the Northwest School of Agri-

culture. An additional cross was made at each experiment station by mating crossbred gilts back to one of the parental breeds. The resulting individuals are designated as back-cross pigs.

At the outset of the experiment, the gilts of each breed were selected from one herd. The purebred gilts used for crossbreeding, in body conformation, were as similar to those used for purebreeding as it was possible to get them. When possible, litter mates were paired, one being used to farrow purebreds and the other to farrow crossbreds. The same boars sired the crossbred and purebred pigs. This was not possible in the case of the three-breed-crosses, but in three-breed-crosses, when possible without inbreeding, boars from the other experiment station were used.



Fig. 1. A Group of Poland China-Duroc Jersey Crossbred Pigs

The objective was to eliminate, in so far as possible, any differences due to the bloodlines used.

Rations fed.—Standard rations were used at both stations throughout the experiment. They were:

Dry gilts—

Grain, 80 per cent, consisting of barley $\frac{2}{3}$ and oats $\frac{1}{3}$.

Protein supplement, 20 per cent, consisting of tankage $\frac{1}{2}$ and linseed meal $\frac{1}{2}$.

(The gilts were fed so as to gain about one pound daily.)

Nursing sows (for eight weeks from birth of pigs)—

Slop-feed consisting of wheat middlings, 90 per cent, and protein supplement, 10 per cent.

Growing and fattening period—

A light slop-feed, continued for four weeks after weaning, and the following, self-fed:

Grain mixture, barley $\frac{3}{4}$, oats $\frac{1}{4}$.

Protein mixture, tankage $\frac{1}{2}$, linseed meal $\frac{1}{2}$.

(Pigs were also run on small rape lots.)

Other environmental conditions.—Pigs were weaned and placed in the feedlot when eight weeks old. They were weighed out of the experiment when they weighed 220 pounds.

EXPERIMENTAL RESULTS

Farrowing results.—The farrowing data, covering six years' work at the two experiment stations, on 1,535 pigs born, are presented in Table 1. Data regarding the purebreds are presented in the first line. The averages for all the purebreds farrowed are arithmetical. In making direct comparisons of the three types of crossbreds with the purebreds, the data regarding the purebreds are proportioned by breeds to the percentage of each breed represented in each of the three types of crossbreds. It will be noted that this makes very little change in the purebred values. For practical purposes, the comparisons of the various groups could be made directly, but the method used is more accurate.

Table 1.—Farrowing Record, Crossbred and Purebred

| Breeding | No. of of sows | No. of indi- viduals | Birth weight per live pig, lb. | Total litter weight of live pigs, lb. | No. live pigs | No. dead pigs | Total litter size |
|--|----------------------|----------------------------|--------------------------------------|---|---------------------|---------------------|-------------------------|
| Average of purebreds | 76 | 715 | 2.45 | 20.98 | 8.26 | 1.15 | 9.41 |
| Purebreds proportioned by breeds to the breeds entering in first-cross | 76 | 715 | 2.55 | 21.14 | 8.29 | 1.11 | 9.40 |
| First-cross | 45 | 440 | 2.60 | 23.97 | 9.22 | .56 | 9.78 |
| Purebreds proportioned by breeds to the breeds entering in the three- breed-cross | 76 | 715 | 2.58 | 21.21 | 8.22 | 1.18 | 9.40 |
| Three-breed-cross | 24 | 245 | 2.59 | 25.59 | 9.88 | .33 | 10.21 |
| Purebreds proportioned by breeds to the breeds entering in the back-cross | 76 | 715 | 2.54 | 21.13 | 8.32 | 1.12 | 9.44 |
| Back-cross | 16 | 135 | 2.91 | 23.66 | 8.13 | .31 | 8.44 |

As a whole, the advantages were decidedly in favor of the crossbreds. They are presented in Table 2. The purebreds excelled the back-cross in the number of live pigs and in the total number of pigs farrowed. In all other respects, the advantages were with the crossbreds. It is obvious that the crossbred sows are better mothers than the purebreds. This is best exemplified by a comparison of the advantages of the first-cross and the three-breed-cross pigs. With the

exception of birth weight per pig, every advantage is held by the three-breed-cross pigs. Birth weight per live pig, apparently, is a rather unsatisfactory standard of comparison, for it is affected considerably by the number of pigs in a litter. The total litter weight of live pigs is a combination of the number of live pigs and the birth weight per live pig, and is likely the most significant standard of comparison between groups at farrowing.

Table 2.—Farrowing Advantages, Crossbreds over Purebreds

| Breeding | Birth weight per live pig, lb. | Birth weight per litter of live pigs, lb. | No. of live pigs | No. fewer dead pigs | Total litter size |
|------------------------|--------------------------------------|---|------------------------|---------------------------|-------------------------|
| First-cross..... | 0.05 | 2.83 | 0.93 | 0.55 | 0.38 |
| Three-breed-cross..... | 0.01 | 4.38 | 1.66 | 0.85 | 0.81 |
| Back-cross..... | 0.37 | 2.53 | -0.19 | 0.81 | -1.00 |

Nursing period.—The data concerning the various groups during the nursing period are presented in Table 3, and the advantages of the various crosses over the purebreds for this period are presented in Table 4. These data are computed by the same method as those in Tables 1 and 2.



Fig. 2. A Group of Chester White-Duroc Jersey Crossbred Pigs

Two are red, one is red with black spots, two are sandy with black spots, and 14 are white.

A study of Tables 3 and 4 shows clearly that the various crosses maintained their advantages throughout the nursing period. In only one respect did the purebreds excel any of the crossbreds. The purebreds' losses per litter were less than the losses among the first-cross pigs. This was undoubtedly due to the large number of first-cross pigs farrowed per litter, and to their being nursed by purebred sows which

were no better mothers than the mothers of the first-cross pigs. The first-cross pigs completed the nursing period with a distinct advantage of 39 pounds more weight per litter than the purebreds.

Table 3.—Nursing Period, Crossbred and Purebred

| Breeding | No. of pigs weaned | No. lost per litter | Litter size at weaning | Weight per pig, lb. | Total litter weight, lb. |
|--|--------------------|---------------------|------------------------|---------------------|--------------------------|
| Average, all purebreds..... | 531 | 2.72 | 5.54 | 28 | 155 |
| Purebreds, proportioned by breeds to breeds in first-cross..... | 531 | 2.67 | 5.62 | 28 | 157 |
| First-cross | 317 | 3.27 | 5.95 | 33 | 196 |
| Purebreds, proportioned by breeds to breed in three-breed-cross..... | 531 | 2.56 | 5.66 | 28 | 158 |
| Three-breed-cross | 186 | 2.17 | 7.71 | 33 | 254 |
| Purebreds, proportioned by breeds to breeds in back-cross..... | 531 | 2.75 | 5.57 | 29 | 162 |
| Back-cross | 100 | 1.88 | 6.25 | 36 | 225 |

Table 4.—Advantages, Nursing Period, Crossbreds over Purebreds

| Breeding | No. lost per litter | Litter size at weaning | Weight per pig, lb. | Total litter weight, lb. |
|-------------------------|---------------------|------------------------|---------------------|--------------------------|
| First-cross | -0.60 | 0.33 | 5 | 39 |
| Three-breed-cross | 0.39 | 2.05 | 5 | 96 |
| Back cross | 0.87 | 0.68 | 7 | 63 |

The superiority of the crossbred mothers is again revealed by the advantages of the three-breed-cross pigs. Their weaning weight per litter was 96 pounds greater than that of the purebreds. Of this 96 pounds advantage, 39 pounds can be attributed to the crossbreeding of the pigs (the advantage of the first-cross pigs). The remaining 57 pounds must be credited to the superiority of the crossbred mothers over the purebred mothers.



Fig. 3. A Litter of Yorkshire-Duroc Jersey Pigs

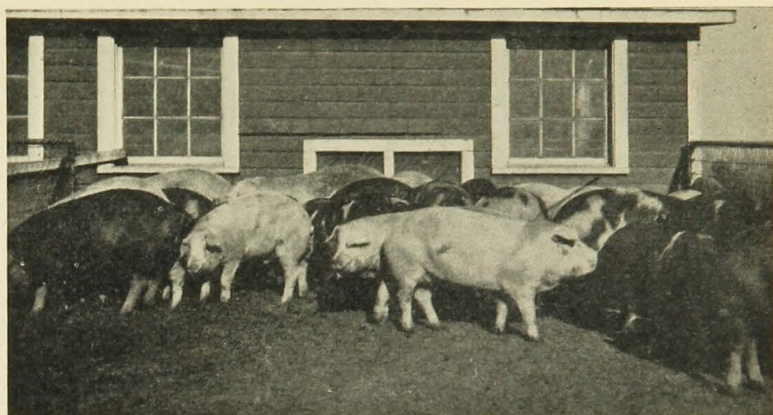


Fig. 4. A Group of Three-breed-cross Pigs

They are the result of a Poland China boar mated to Chester White-Duroc Jersey sows.

The method of comparison given holds remarkably well when applied to the back-cross pigs. Back-cross pigs are on the average three-fourths of one breed and one-fourth of another. This makes them essentially one-half crossbred. On the basis of the pigs' own crossbreeding, we may expect them to have a total litter weight advantage at weaning of 19.5 pounds ($\frac{1}{2}$ of 39) over the purebreds. This leaves an advantage of 43.5 pounds that can be credited to the crossbred mothers.

The total litter weight at weaning is the best method of comparing the merits of the various groups during the nursing period. In this respect, all three groups of crossbreds excelled the purebreds. The three-breed-cross pigs again possessed the greatest advantage, with the back-cross pigs a close second. The back-cross pigs showed up remarkably well by this method of comparison. Even tho the number of pigs per litter was slightly less at farrowing time, the number of pounds of pig weaned per litter was close to that of the three-breed-cross group.

The growing and finishing period.—The advantages of the crossbred pigs over the purebreds from weaning to finishing are presented in Table 5. These data are computed in a manner slightly different from those in Tables 1 to 4. The results of each year's experiment at each station were taken as a unit of comparison. The data in Table 5 were obtained by averaging the above-mentioned units. Comparisons at this point can be made by several other methods.

Arithmetical averages for all the swine fed at both stations for the six years give one possible method of comparison. This, however,

is a rather crude method for the growing finishing period, because it does not make adequate allowance for changing environmental conditions from year to year. In addition, the proportionate number of pigs in each of the lots was not the same each year or at both stations.

**Table 5.—Advantages, Rate and Economy of Gains,
Crossbreds over Purebreds**

| Breeding | No. of lots | No. of indi- viduals | Feedlot period | | Birth to 220-pound weight | |
|-------------------------|----------------|----------------------------|-------------------------|-------------------------------------|--------------------------------------|---|
| | | | Pounds daily gain | Less feed per 100 pounds gain | Fewer days to reach 220 pounds | Fewer pounds feed per 220- pound pig |
| Purebred | 21 | 353 | | | | |
| First-cross | 15 | 229 | 0.12 | 12.68 | 17 | 27.90 |
| Three-breed-cross | 8 | 173 | 0.11 | 16.21 | 17 | 35.66 |
| Back-cross | 5 | 93 | 0.14 | 12.15 | 22 | 26.73 |

Another method of comparison is to take each year's work at each station as a unit, as outlined above, but to compute the results with each group of crossbreds on the basis of the proportionate advantage or disadvantage of each crossbred pig per lot.

All of these methods of comparison were used, and the crossbreds showed an advantage over the purebreds by each method and each item of comparison. A more remarkable fact is that the results did not differ particularly regardless of the method used. The authors feel that the method used for presentation is the more nearly accurate of the three. It gives the more conservative advantages for the crossbred swine, but the results are slightly more consistent.

What is more impressive from an experimental standpoint is that every lot of crossbreds (28) outgained the purebreds during the growing and fattening period and reached market weight at an earlier date, and only 3 of the 28 lots required more feed per 100 pounds of gain.

Following weaning the three types of crossbred swine continued to grow faster than the purebreds. The advantages of the first-cross and the three-breed-cross pigs were essentially the same. The back-cross pigs excelled both other groups of crossbred pigs during this period. Their advantage was slight and may have been due to chance, or, on the other hand, it may have been due to their slightly greater weaning weight.

The advantage of faster gains during both the nursing and after-nursing periods was cumulative, and was apparent in the shorter time required by the crossbreds to reach market weight. The authors feel that this shortening of the time necessary to reach market weight and the increased weight per litter at weaning are two very important economic advantages possessed by the crossbred pigs.

The advantages of the crossbreds in economy of gains are 28, 36, and 27 pounds of feed per pig, for the first-cross, three-breed-cross, and back-cross pigs, respectively. These differences are not particularly large, but they are large enough to constitute, under many conditions, the difference between profit or loss on a pig crop. Roughly, the advantage of the cross-bred pigs with respect to economy of gains amounts to one-half bushel of corn per pig for the first-cross and back-cross groups and two-thirds of a bushel for the three-breed-cross.

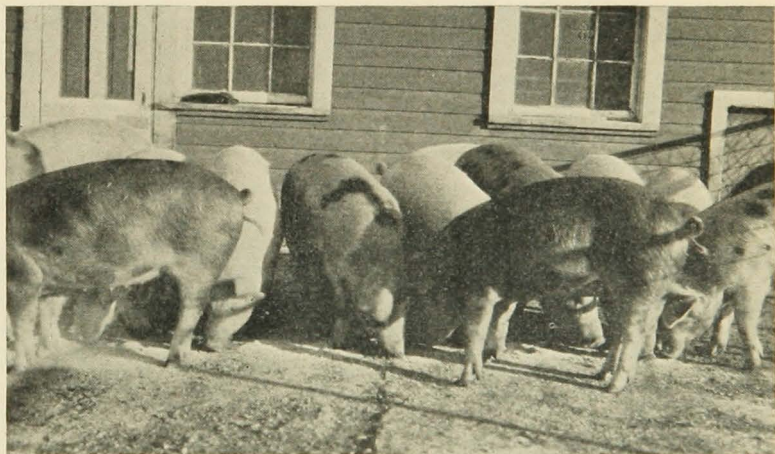


Fig. 5. A Three-breed-cross, the Result of Mating Poland China-Yorkshire Sows to a Duroc Jersey Boar

Summary of experimental results.—With the exceptions of the number of live pigs farrowed, and of the total number of pigs farrowed, per sow in the back-cross group, the crossbreds excelled the purebreds in every item of comparison. The back-cross group constituted the smallest group, and there was more irregularity in the results obtained from this group. It is, therefore, doubtful whether we can place quite as much reliance on each item of comparison between the back-cross pigs and the purebreds as on the detailed comparisons of the other crosses with the purebreds. Taken as a whole, the back-cross group shows a decided superiority over the purebreds for market hog production, and the authors believe that if the numbers of back-cross pigs were increased, the slight irregularities in advantages would be smoothed out.

Table 6 and Figure 7 give summaries for contrasting the comparative merits of the various crossbreds with the purebreds on a percentage basis. Taken as a whole, the first-cross and back-cross pigs had about the same advantage over the purebreds. The three-breed-

cross group possessed the greatest advantage by nearly every item of comparison. They combined the advantages of being crossbreds themselves and of being out of crossbred sows. The back-cross pigs had the full advantage of being out of crossbred sows, but, on the average, they possessed only one-half the advantage of being crossbreds since they were three-fourths of one breed and one-fourth of the other.

Table 6.—Summary of Advantages of Crossbreds over Purebreds, in Percentage

| | First-cross | Three-breed-cross | Back-cross |
|---|-------------|-------------------|------------|
| Birth weight per live pig | 1.96 | 0.39 | 14.57 |
| Birth weight per litter of live pigs..... | 13.39 | 20.65 | 11.97 |
| Number of live pigs per litter | 11.22 | 20.19 | —2.34 |
| Total number of pigs per litter | 4.04 | 8.62 | —11.85 |
| Number of pigs weaned per litter..... | 5.87 | 36.22 | 12.21 |
| Litter weight at weaning | 24.84 | 60.76 | 38.89 |
| Saving in feed | 2.99 | 3.85 | 2.91 |
| Saving in time to reach 220 pounds..... | 8.67 | 8.63 | 11.28 |

Of the various items of comparison the three that are probably of most importance to the commercial swine producer are litter size and weight at weaning, saving in time to reach market weight, and saving in feed. They are probably of importance in the order given. The heaviest losses of pigs come before weaning time. The weight per litter at weaning time is affected by the number of live pigs farrowed, the losses during nursing, and the rate of growth. The weight of the litter at weaning is, therefore, a satisfactory indication of how well

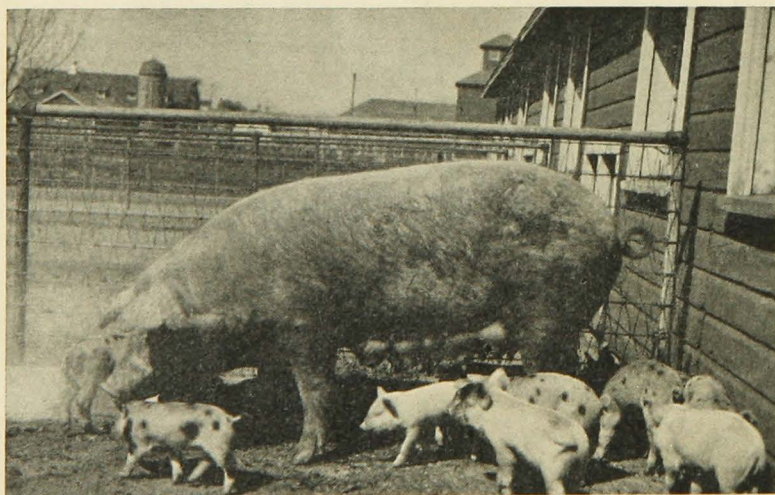


Fig. 6. A Three-breed-cross Litter, the Result of Mating a Poland China-Yorkshire Sow to a Duroc Jersey Boar

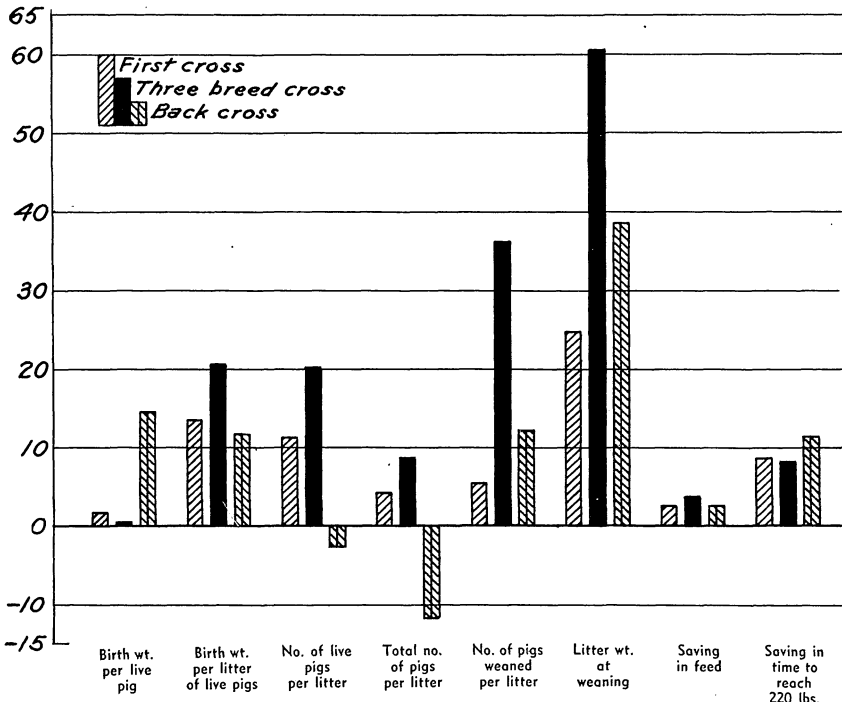


Fig. 7. Percentage Superiority of the Three Groups of Crossbreds Over Comparable Purebreds

the pigs have come through that critical period. In that respect, all three groups of crossbreds excelled the purebreds by rather wide margins. It appears that the crossbred sows were a greater factor in promoting growth up to weaning than the crossbreeding of the pigs. The first-cross pigs had an advantage of 39 pounds per litter, whereas the three-breed-cross had a litter advantage of 96 pounds, or 57 pounds more than the first-cross pigs. By similar analogy, we can attribute 19.5 pounds ($\frac{1}{2}$ of 39) of the 63 pounds greater weight of the back-cross pigs to their own crossbreeding, and the remaining 43.5 pounds to the superiority of the crossbred mothers.

To reach market weight in the shortest time possible is of distinct economic advantage. Possibilities of loss are reduced by exactly the number of days by which the time is shortened, some of the usual bad weather in either spring or autumn is avoided, and it is possible to reach the earlier autumn market which usually offers higher prices than the later market. All three groups of crossbred swine grew faster and reached market earlier than the purebreds. The back-cross group possessed the greatest advantage in this respect, but it is doubtful whether the difference is significant, because the number was somewhat smaller than in either of the other crossbred groups.

The advantage in feed saved was significantly in favor of each of the three crossbred groups. One-half bushel of corn saved per pig on each of the first-cross and back-cross groups and two-thirds of a bushel on the three-breed-cross group is well worthwhile in economical swine production.

GENERAL OBSERVATIONS

A further possible method of comparison is based on the comparative merits of the various groups as market animals. Such a comparison was not included, because of the extreme difficulty in making comparisons that would be wholly satisfactory. The pigs (even within a group) reached market weight at different dates, and that was complicated by the further fact that both stations are a considerable distance from a central market. The observation of all workers connected with this experiment, however, is that all three groups of crossbreds were better market hogs than the purebreds. It is certain that they would have sold at prices fully as high as the purebreds.

The crossbred sows had the appearance of being good brood-sows; their udders were large, and they were quiet and easily handled. The senior author, when visiting the stations, made it a point each year to ask the caretakers how they liked the crossbred sows. The answer, without hesitation in every instance, was that the men doing the work of feeding and caring for the hogs favored the crossbred sows. The authors believe that this is of some significance, because in working with breeding stock there are some things that cannot be reduced to figures for comparison.

Color of the crossbred pigs.—Color of farm animals is a matter of interest and frequently affects commercial value. The colors that may be expected from the various crosses made in this experiment are as follows:

Duroc Jersey x Poland China; red with small black spots.

Duroc Jersey x Chester White; white with some sandy hair.

Duroc Jersey x Yorkshire; white with sandy hair and a number of black skin spots.

Poland China x Yorkshire; white.

Duroc Jersey-Poland China x Chester White; white, with one-half showing sandy hair and one-half a few black spots.

Duroc Jersey-Poland China x Yorkshire; white, with a varying number of colored areas in the skin and a few definitely small black spots.

Duroc Jersey-Chester White x Poland China; one-half white, one-half spotted (mostly white with black spots or a few red spots).

Poland China-Yorkshire x Duroc Jersey; one-half white, one-half red with black spots.

Duroc Jersey-Poland China x Duroc Jersey; red, with a few black spots.

Duroc Jersey-Chester White x Duroc Jersey; one-half white or sandy, one-half red, with or without black spots.

Poland China-Yorkshire x Poland China; one-half white, one-half white with black spots.

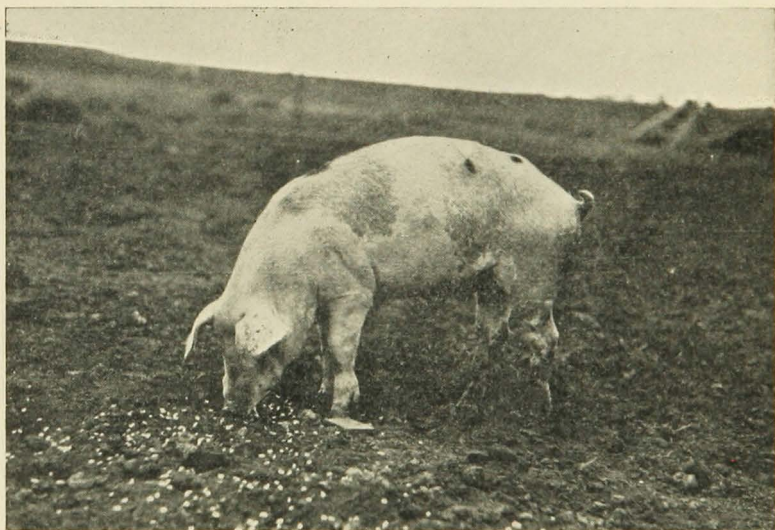


Fig. 8. A Three-breed-cross Pig, the Result of Mating a Yorkshire Boar to a Poland China-Duroc Jersey Sow

All the other pigs in this group were white with a little sandy touch.

The foregoing is what may be expected on the basis of the results obtained in this experiment. But a number of marked deviations from the expected were obtained. The Yorkshire white is supposedly a dominant white, which, when crossed with Duroc Jerseys or Poland Chinas will leave all the resulting pigs white. Five different, well-bred, purebred Yorkshire boars were used in this experiment and each of the boars sired one or more rather highly colored pigs. An interesting litter (Figure 3) resulted from a Duroc Jersey sow mated to a Yorkshire boar. Ten pigs resulted, four of which were essentially white and six more or less colored. Of the six that were colored, three had rather definite white belts. This particular Yorkshire boar apparently carried the pattern for belt.

In one litter of Chester White x Duroc Jersey, two pigs were red with black spots, two were sandy with black spots, and one was white.

In two other litters by the same boar, one pig in each litter was sandy with black spots.

A new method of breeding swine for market.—The results obtained from this six years' experiment have made it very clear that the three types of crossbreds produced are superior for market hog production to purebreds of comparable bloodlines. It has been proved very conclusively that the old, rather standard, advice that crossbred sows should all be marketed is erroneous, for the crossbred sows excelled the purebreds as mothers, whether mated to a boar of a third breed or back to one of the breeds that entered in her own breeding. It is, therefore, very clear that there is as much benefit from keeping the crossbred sows for breeding as there is in making the original cross.



Fig. 9. A Group of Back-cross Pigs, the Result of Using a Duroc Jersey Boar on Poland China-Duroc Jersey Sows

Two opportunities are open to the farmer wishing to use the crossbred sows. One is to mate them to a boar of a third breed, and the second is to back-cross them to one of their own two parental breeds. In spite of the fact that the three-breed-cross gave the greatest increase in vigor, the authors question the advisability of this as a general practice, because it is somewhat more complicated when considered from the long-time viewpoint. The back-cross presents a rather simple solution of the problem. There is no reason why a farmer cannot continue alternating indefinitely in the use of boars of two breeds. This proposed method of breeding may be labeled "crisscross breeding." The pedigree of a pig after five generations of this type of breeding would be as illustrated in Figure 10, depending on the breeds used.

The method of breeding swine for the market, proposed above, is being carefully tested at the Minnesota Experiment Station in an experiment which will continue for several years.

It was hoped that, from the experiment reported in this bulletin, we would be able to obtain some information as to which breeds might be expected to give the greatest amount of increased vigor when crossed, for there are scientific reasons for expecting that some breeds will cross to better advantage than others. When this experiment was sub-divided on the basis of the breeds crossed, however, the numbers were too small to warrant sound conclusions regarding such differences.

The authors suggest that a farmer select two of the popular American breeds of swine, according to his own preferences, and proceed to breed for the market by first using a boar of one breed and then of the other. The same method can be applied to the three-breed-cross, by rotating the use of boars of three breeds, but, as already pointed out, this is somewhat more complicated.

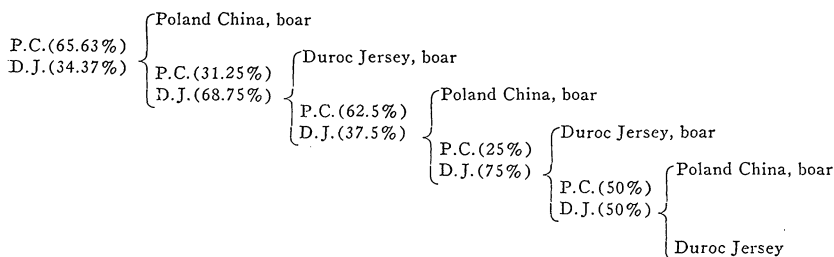


Fig. 10. The Pedigree of a Pig After Five Generations of Crisscross Breeding

The purebred and crisscross breeding.—The good purebred sire is the basis for a sound beginning in breeding swine or any other class of livestock for the market. This is equally true of the method of breeding market swine, here proposed. Crossbreeding will not solve any difficulties, or contribute anything to constructive pork production, unless good purebred sires are used. The purebred breeder has nothing to fear from the proposed method of breeding for the market. In fact, he has something to gain, for good purebreds will be used in the practice, and there should be a demand for many purebred boars.

SUMMARY AND CONCLUSIONS

1. The experiment described was in progress at the Minnesota Experiment Station from 1928 to 1934.
2. Forty-nine lots of swine were carried through the experiment, comprising a total of 1,535 pigs farrowed. Of these, 1,410 were far-

rowed alive, 1,134 were carried to weaning, and 848 were finished for the market.

3. The first-cross, the three-breed-cross, and the back-cross groups were all superior to comparable purebreds.

4. The first-cross and the back-cross groups were approximately equal in superiority to the purebreds, but both were excelled by the three-breed-cross.

5. The crossbred sows were superior to purebreds for producing market pigs. The resulting pigs benefited as much from being out of crossbred sows as they did from being crossbreds themselves.

6. The three items of comparison that are of most concern to the commercial swine producer are the increased litter size and weight at weaning, the decreased time necessary to reach market weight, and the decreased feed necessary for a pound of gain.

7. The crossbred litters averaged from one-third pig to two pigs larger at weaning; on the average, each pig weighed from 5 to 7 pounds more at weaning, and the litters weighed from 39 to 96 pounds more than the purebreds.

8. The crossbred pigs reached a market weight of 220 pounds from 17 to 22 days earlier than comparable purebreds, and they reached that weight on from 27 to 36 fewer pounds of grain.

9. A new method of breeding market swine, labeled crisscrossing, is recommended as a result of this experiment.